PROJECT SUMMARY SHEET

PROJECT TITLE NAME: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading

NAME, ADDRESS, PHONE AND E-MAIL OF LEAD PROJECT SPONSOR OR SUB GRANTEE: David R. German, South Dakota State University, Water Resources Institute, Box 2120, Brookings, SD 57007; Ph. 605-688-5611; E-mail: David.German@sdstate.edu

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STATE: South Dakota **WATERSHED:** South Dakota East of Missouri River

HYDROLOGIC UNIT CODE: **HIGH PRIORITY WATERSHED** (yes/no): No

TMDL Development ( ) and/or Implementation (X) (check any that apply)

PROJECT TYPES: [ ] **Base** [ ] **Watershed** [ ] **Groundwater** [X] **I&E**

WATER BODY TYPES:
[ ] GROUNDWATER
[X] RIVERS
[X] STREAMS
[ ] WETLANDS
[X] LAKES/RESERVOIRS
[ ] OTHER

NPS CATEGORY:
[X] AGRICULTURE
[ ] URBAN RUNOFF
[ ] SILVICULTURE
[ ] CONSTRUCTION
[ ] RESOURCE EXTRACTION
[ ] STOWAGE AND LAND DISPOSAL
[ ] HYDRAULIC MODIFICATION
[ ] OTHER

PROJECT LOCATION: Brookings County in South Dakota

SUMMARIZATION OF MAJOR GOALS: The project goal is: "Evaluate the environmental risk of spreading manure during winter conditions and develop BMPs for winter manure spreading that minimize water quality impacts." The goal will be attained by completing activities designed to reach four objectives: 1) Assess the risk of spreading manure on frozen soils, 2) Compare winter manure spreading practices related to location, timing and placement to determine which minimize water quality impacts and develop BMPs, 3) Develop a climatic risk factor using frequency of soil frost and rainfall events, and 4) Provide education on winter manure spreading BMPs to livestock producers, extension educators, and resource managers.

PROJECT DESCRIPTION:
Nutrient, sediment and bacteria loss at the plot and watershed scale will be monitored by placing flumes at the outlets of each of six small watershed areas. The continuous record of discharge and water quality samples will be used to calculate loads of suspended sediments, nutrients, and fecal coliform loads from each watershed and plot. Different winter manure spreading practices will be compared to evaluate the risk of water quality degradation. The information gained will be used to develop management strategies that more effectively reduce nutrient, sediment, and bacteria loading to surface water and the accelerated eutrophication of lakes and streams in the state.

FY 2009-2011 **319 funds requested:** $161,034 **Match:** $107,360
Other Federal Funds $ 0 **Total project cost:** $ 268,395
319 Funded Full Time Personnel: 0.36

2.0 STATEMENT OF NEED

Importance of project: Livestock production is a major component of the South Dakota economy. Because the economic importance of livestock production crosses watershed boundaries and affects both the rural and urban population, especially in heavily populated watersheds, the issue of manure management has been the subject of debate in recent years. At the center of this debate is the land application of manure and the possible impacts on the state's water resources as nonpoint source (NPS) discharges of pollutants can be significant, especially where high concentrations of livestock are present if manure is not managed properly.

Fecal coliform bacteria, nutrients, and sediment have been identified as sources of water resource impairment in many SD watersheds (SD DENR, 2006). Fecal coliform bacteria and sediment impact the use of rivers and streams for boating, fishing, swimming, and other recreational uses while high Trophic State Indexes (TSIs) associated with excessive phosphorus loading limits beneficial uses of many lakes. Due to potential impacts on water quality the South Dakota Department of Environment and Natural Resources (SD DENR) has developed rules for land applications of manure through a permit process. Current SD DENR rules discourage the application of manure to frozen soils, but do not prohibit the practice. Livestock producers using several USDA/NRCS programs are limited in their use of winter manure spreading practices. The NRCS enforces winter spreading restrictions through the 590 standard which is under review. The proposed standard if adopted may allow 10 percent of annual manure production to be spread in winter months with certain restrictions on placement. In any case, winter spreading of manure is likely to continue in South Dakota to some degree in the future, therefore, BMPs to reduce impacts to water quality are needed.

Spreading manure on frozen ground is an important management issue for livestock producers since winter spreading of manure reduces the quantity of winter storage needed, provides more time for application on cropland and reduces soil compaction problems. While winter application of manure is often limited by recommendation, Srininvasan et al. (2006) reported that limitations on the application of manure during winter periods were determined largely from perceptions, not scientific data.

Several studies show lower runoff volumes and sediment loss from manured areas compared to non-manured or control areas (Young, 1974; Young and Mutchler, 1976; Hensler et al.,1970; McCaskey et al.,1971) cited in Khaleel, 1980. The volume of runoff is often less from winter spread manure (Converse, 1976) (Witzel, 1969) (Meals, 1991) (Young, 1976) although concentrations of dissolved P in runoff are often higher.

The results of observational studies are mixed. Several studies have shown that winter spreading of manure results in higher losses of P in runoff from manure spread at other times of the year in Wisconsin (Hensler et al,1970) and Vermont (Meals,1991). Other studies have shown only slightly higher (Young, 1976) or similar (Witzel,1969) losses of P in runoff when manure is spread during the winter months.

Several studies conducted in other areas of the country cause livestock producers to question their validity in South Dakota. Little work has been done based on soil and climatic conditions in South Dakota to determine BMPs for the livestock industry in South Dakota. Livestock producers were also concerned that sound scientific data on winter applications would be available for rule-making for the NRCS 590 guidelines and the SD DENR manure

management plans for permitted feedlots. In a recent literature review, Srinivasan et. al., 2006 lists several key research and management issues that need to be addressed. They are:

1. Characterization of the changes in the physical and chemical properties of manure under winter conditions as they affect nitrogen (N) and P release rates;

2. Development of strategies and methods that relate the findings of small-scale experiments to large-scale soil, landscape, and climate patterns;

3. Collection of sufficient data to establish the linkages among watershed-scale water quality, winter manure spreading practices, and winter conditions that affect hydrology and erosion processes;

4. Development of empirical model(s) of snowmelt and nutrient transport for use in evaluating current winter spreading practices and developing BMPs; and

5. Development of alternate methods of manure application.

Additional research to evaluate current winter spreading practices and develop best management practices (BMPs) that reduce the water quality impacts of spreading manure on frozen soil is needed. The proposed project is designed to fill some of the knowledge gaps that have been identified in understanding winter manure spreading and impacts on water quality, and to collect data under conditions common to the state and develop risk assessments based on available data. Based on the information gained, tools will be developed to assist livestock producers in making decisions about when and how to apply manure in an environmentally responsible manner.

3.0 PROJECT DESCRIPTION

3.1 Project Goal: The project goal is: "Evaluate the environmental risk of spreading manure in winter conditions and develop BMPs for winter manure spreading that minimize impacts to water quality". The proposed project will assess the relationship that exists between timing and placement of winter spread manure and water quality of field runoff at the watershed scale and plot scale. This project will provide soil scientists and resource managers with the data from which to develop a better understanding of the risks associated with winter spreading practices and the factors governing nutrient and sediment loss. Based on the information gained, BMPs will be identified that effectively reduce nutrient and sediment loading to surface water resources and the accelerated eutrophication of lakes and streams in the state.

The goal will be attained by reaching the following four objectives:

1. Complete an assessment of the risk of spreading manure on frozen soils,
2. Compare winter manure spreading practices in relation to location, timing and placement to determine which minimize impacts to water quality and develop BMPs,
3. Develop climatic risk factors using frequency of soil frost and rainfall events on the risk of manure application to assist livestock producers in timing manure applications during least risky time periods, and

4. Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and various environmental stakeholders.

3.2 Project Objectives

Objective 1: Complete an assessment of the risk of spreading manure on frozen soils.

Six small watersheds will be studied at two locations near Brookings, SD. Each location will contain a cluster of three adjacent watersheds adjacent. One cluster of three small watersheds were established for a project titled "Evaluating Phosphorus Loss on a Watershed Scale" (Watershed P study). These existing watersheds were used to determine the relationship that exists between P loss at the plot scale with P loss at the watershed scale. These watersheds will be referred to as the "SDSU Watersheds." Three additional watershed areas were established on a cooperator's land (Mike Schmidt) south of Brookings during 2008. These watersheds will be referred to as the "Schmidt Watersheds." The Water Resources Institute, Moody Conservation District, East Dakota Water Development District, South Dakota Farm Bureau, Mike Schmidt, and the USGS 104b program contributed funds to establish the Schmidt Watersheds and conduct runoff monitoring during the spring of 2008.

The study design used will be a paired watershed approach (Clausen and Spooner, 1993). The paired watershed design is effective for documenting a linkage between land treatment and water quality changes in small watersheds over a relatively short time period. This method uses two time periods (calibration and treatment) with at least two watersheds (control and treatment). In this project each cluster of watersheds will consist of a control and two treatments for each watershed cluster. During calibration, no changes occur in the watersheds while monitoring of watershed discharge and pollutant concentrations in runoff are used to establish pollutant-runoff response relationships for each watershed. During treatment, only the treatment watershed is modified. This study design eliminates the effects of inter-annual climatic variation on water quality. Following the initial calibration period, one (or two) of the watersheds receives land treatment while the other (control) watershed does not. Monitoring of both watersheds continues for one to three years. The recommended method of analysis for paired watershed designs is simple analysis of covariance (ANCOVA) on time aggregated data.

Figure 1 shows the three SDSU Watersheds as delineated using a Global Positioning Receiver (GPS) and a Handheld Geographical Information System. The elevations are exaggerated in the vertical scale to accentuate the watershed boundaries. Each watershed is approximately 5.6 acres in area. The red box in Figure 1 represents the discharge area of the three watersheds where the flumes and monitoring equipment are located (Figure 2).

Figure 3 shows the orientation of the Schmidt Watersheds which are located three miles south of the I-29 and Highway 34 interchange east of Madison, SD in Moody County. The south watershed is 10.2 acres, the north watershed is 6.7 acres, and the east watershed is 6.8 acres. Watershed outlets where flumes and stage recorders were installed during 2008 are shown in Figure 3.

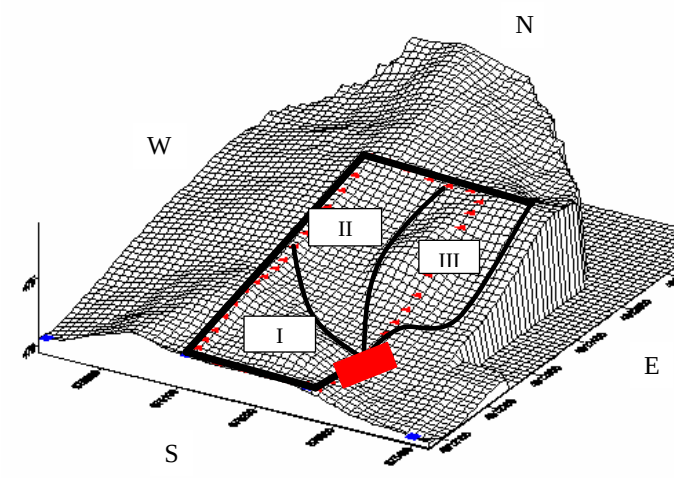


Figure 1. Three watershed boundaries approximately 5.6 acres in size (Brookings).

Figure 2. A Gauge House located above the flumes houses sampling equipment.

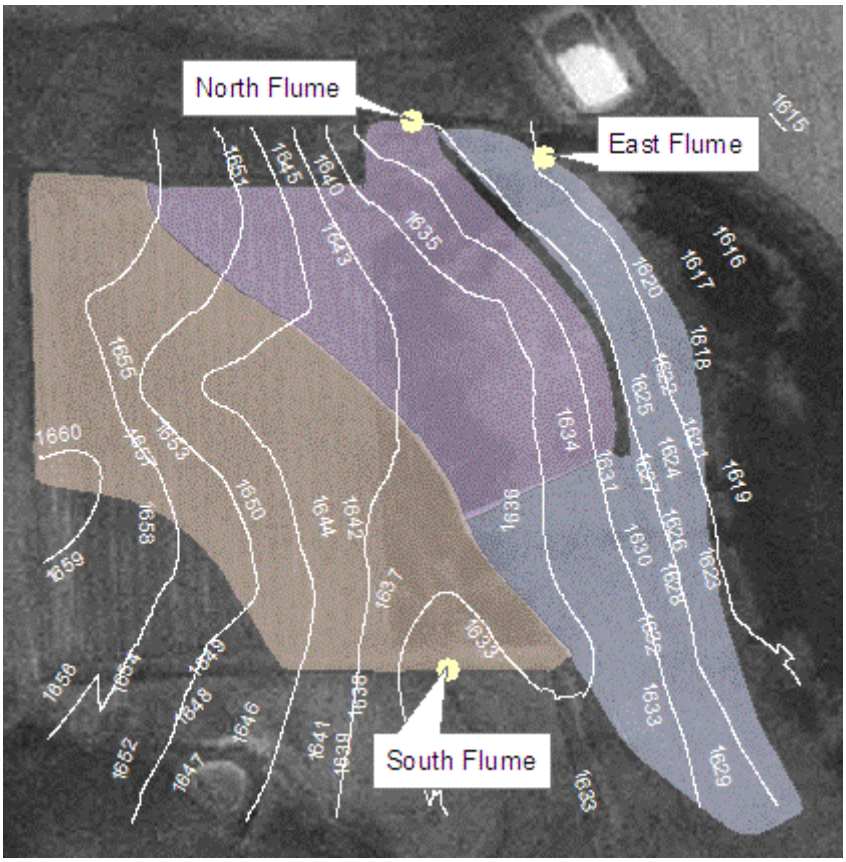


Figure 3. Schmidt Watersheds showing ortho image and elevation contours.

Figure 4. Instrumentation located above the flumes inside the gauge house (Brookings).

The three SDSU Watersheds developed for the Watershed P study are located on university-owned land. The watersheds were established with similar land cover and use, surface roughness, and soil characteristics during 2005 and have been cropped to continuous corn from 2005 through 2008. One H-flume was installed as a hydrologic control on the discharge site for each watershed. Each flume is equipped with Stevens Type F stage recorders and fitted with a Thalimedes electronic stage recorder (Figure 4). The Schmidt Watersheds were equipped with H-flumes and Stevens Type F stage recorders during 2007. Each Thalimedes stage recorder transfers data to a NexSens data logger. The data logger also receives data from an Isco tipping bucket rain gage. The NexSens is queried through a modem by a computer at the Water Resources Institute using NexSens iChart Software. An information specialist at the Water Resources Institute downloads data from the data logger and formats the data for analysis.

The NexSens iChart Software was programmed to send an e-mail and a text message to at least three project team members both upon the detection of rainfall and the commencement of flow in the H flumes. The information specialist at the Water Resources Institute will manage the hydrologic data in the current proposed project. The current instrumentation system will also be maintained with modifications and improvements to collect soil moisture and soil temperature data, which have collected data for one winter already. Rapid response to runoff events as indicated by the NexSens system will permit grab sampling for fecal coliform bacteria in a timely manner.

The Watershed P study ended during December 2007 releasing the three SDSU Watersheds for the proposed project. The SDSU Watersheds were calibrated for phosphorus and nitrogen loss during the Watershed P study. Fecal coliform bacteria data was not included in the Watershed P study. Therefore, calibration data for bacteria numbers is not available. The Watershed P study amassed two years of runoff and nutrient loss data at the watershed scale which can be used as the calibration phase in a paired watershed experimental design to evaluate manure management BMPs. Since calibration of the existing watersheds was completed as part of the Watershed P study evaluation of winter spreading practices began during spring 2008.

During 2007 and 2008 the SDSU Watersheds received the following treatments: 1) South watershed: no manure applied, 2) middle watershed fall applied manure at the N rate and incorporated, and 3) winter applied manure at the N rate.

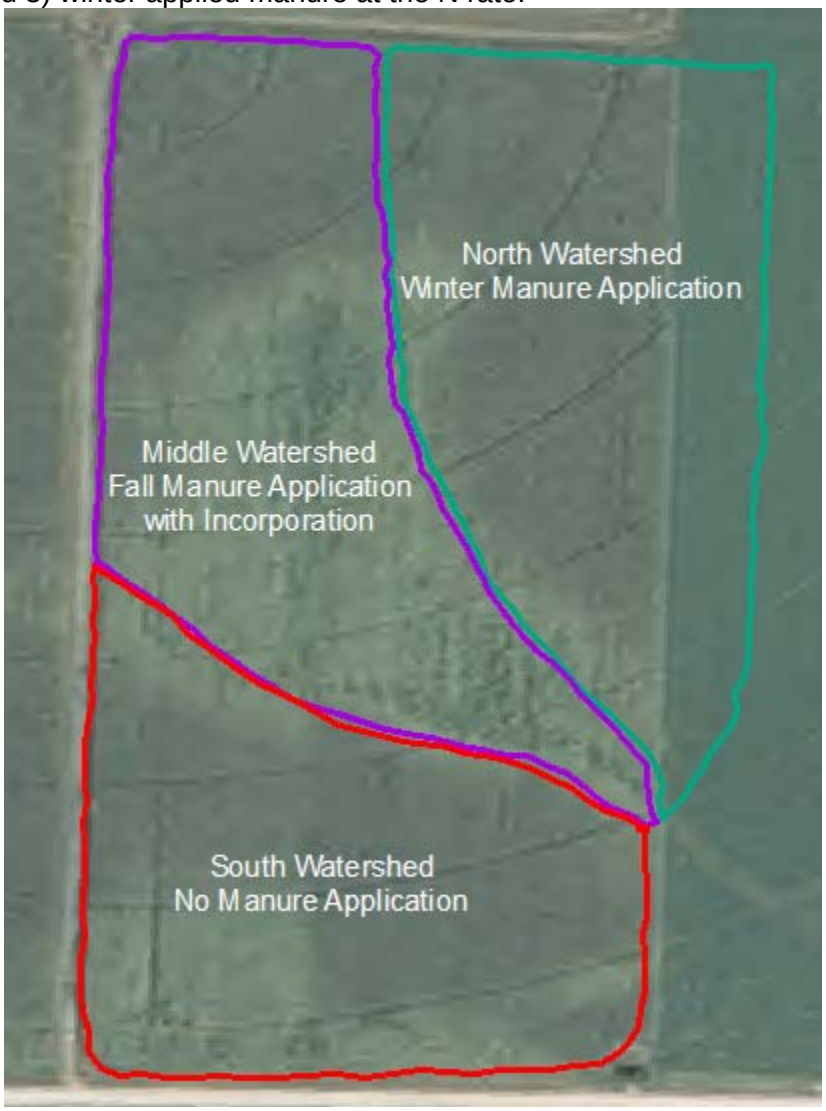


Figure 5. Treatments on SDSU Watersheds

Runoff sampling was conducted on the SDSU Watersheds during the spring of 2008 from several small snow melt events. Mean concentrations of suspended sediment (Figure 6), phosphorus (Figure 7), ammonia (Figure 8), Total Kjeldahl Nitrogen (TKN) (Figure 9), and fecal coliform bacteria (Figure 10) are presented in Figures 6-10. Suspended sediment concentrations in runoff from the manured watersheds (middle and north) was less than suspended sediment concentrations in runoff from the south watershed, which received no manure (Figure 6). This is consistent with other studies of winter applied manure (Young, 1974; Young and Mutchler, 1976; Hensler et al.,1970; McCaskey et al.,1971). Phosphorus concentrations were higher in runoff from the manured watersheds compared to the south watershed (Figure 7). Phosphorus concentration in runoff from the middle watershed which received a fall application of manure was not significantly different than the north watershed which received manure in March 2008. Ammonia, TKN, and fecal coliform numbers (Figures 8-10) were all higher in runoff from the north watershed compared to the middle watershed (fall

application) or the control (south watershed). Data collected during 2008 was insufficient to conduct analysis of covariance for the paired watershed design. This treatment will be repeated during 2009 to collect additional data necessary for analysis.

Figure 6.

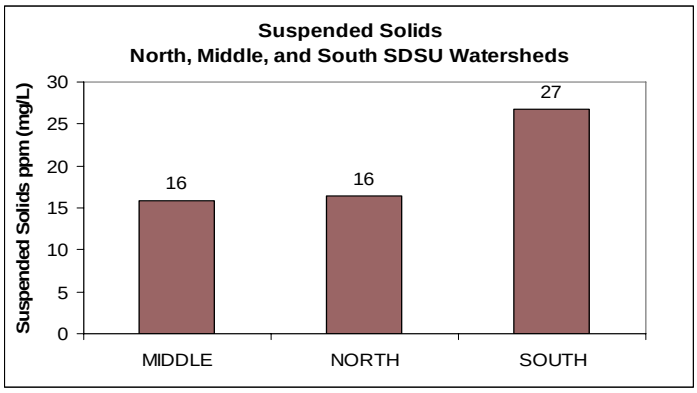


Figure 7.

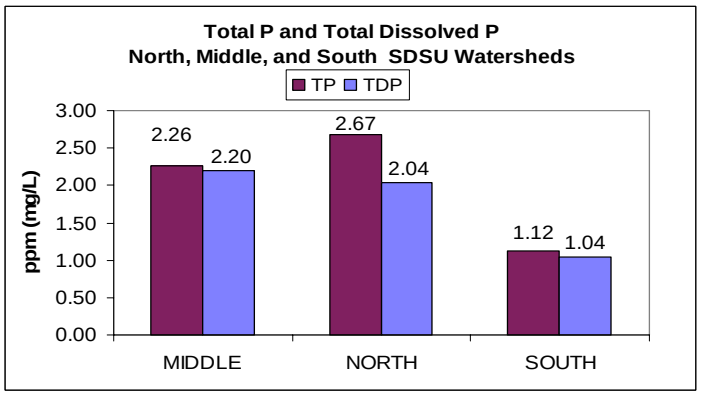
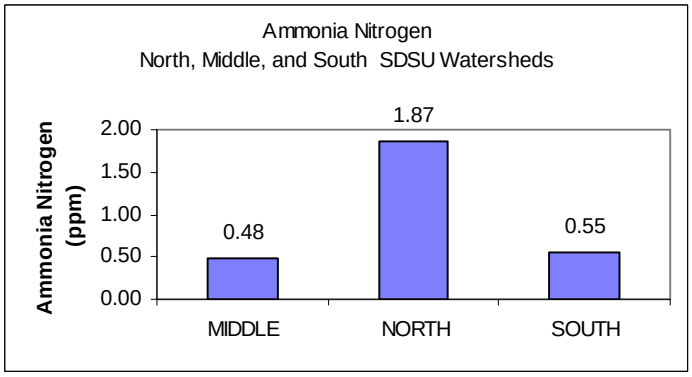


Figure 8.



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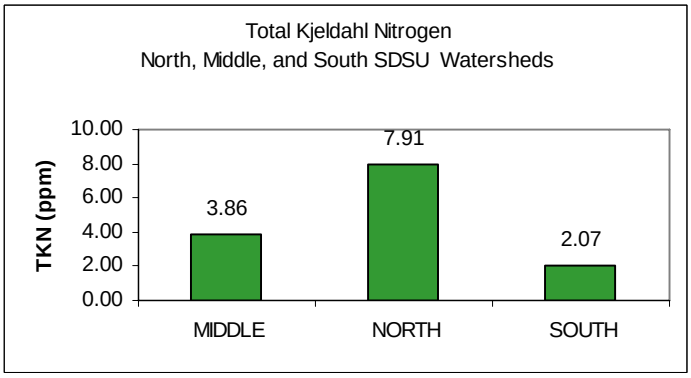
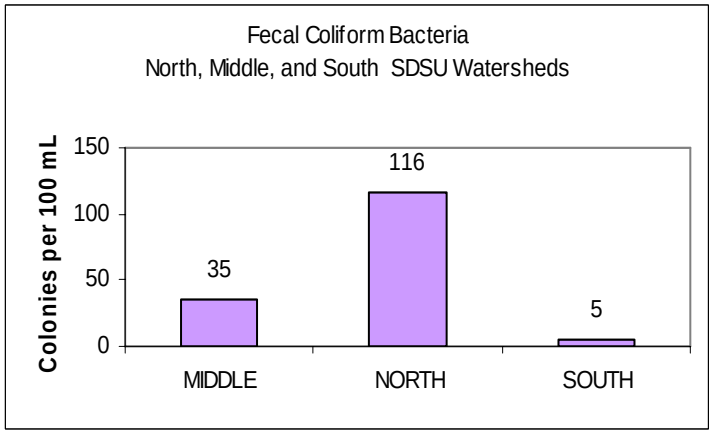


Figure 10.



Three new watershed areas ranging from 5 to 10 acres in size were located on Mike Schmidt's land during 2008. Each watershed area contains a drainage area similar in length, slope, and shape. All were established with similar land cover and use, surface roughness, and soil characteristics. Soybean stubble was present during spring 2008 (Figure 3). Runoff sampling was conducted on the Schmidt Watersheds during 2008 to begin the calibration period. Less snowfall was available to melt during 2008 at the Schmidt site compared to the SDSU site. The Schmidt site was also located in a higher landscape position compared to the SDSU site and exhibited drier soil conditions during 2008. These factors resulted in less runoff activity at the Schmidt Watersheds during 2008 compared to the SDSU Watersheds. Mean concentrations of suspended sediment (Figure 11), phosphorus (Figure 12), ammonia (Figure 13), TKN (Figure 14) and fecal coliform bacteria (Figure 15) in runoff from the Schmidt Watersheds are presented in Figures 11-15 respectively.

Figure 11.

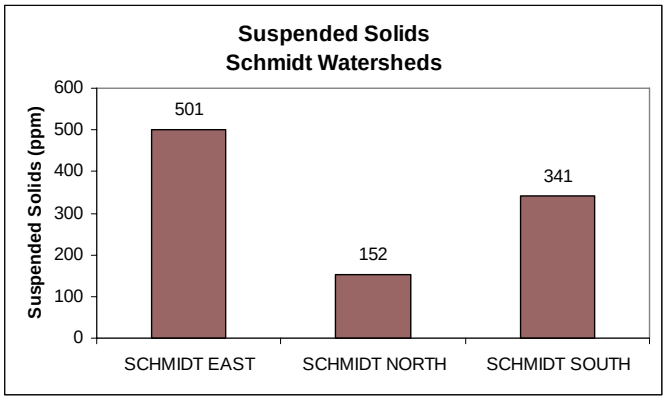


Figure 12.

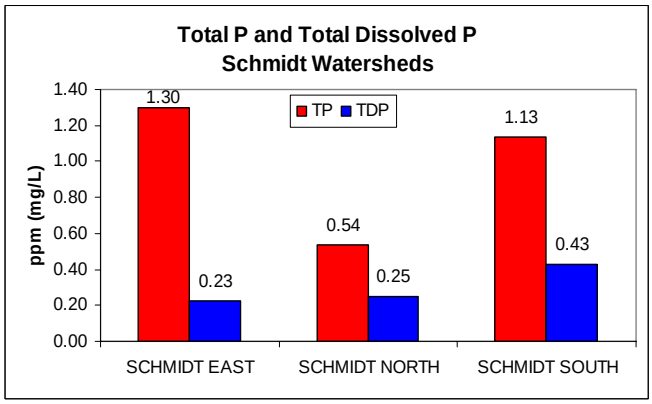


Figure 13.

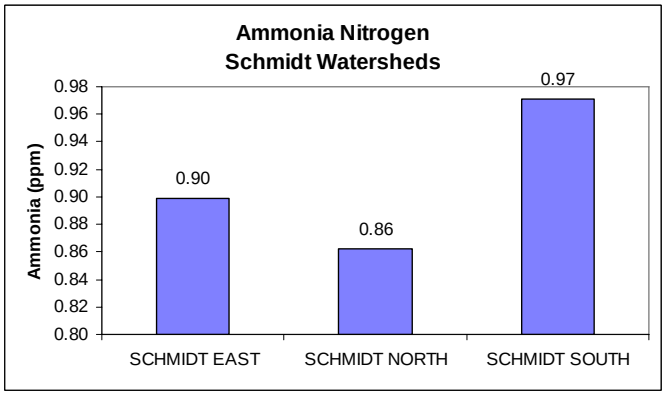


Figure 14.

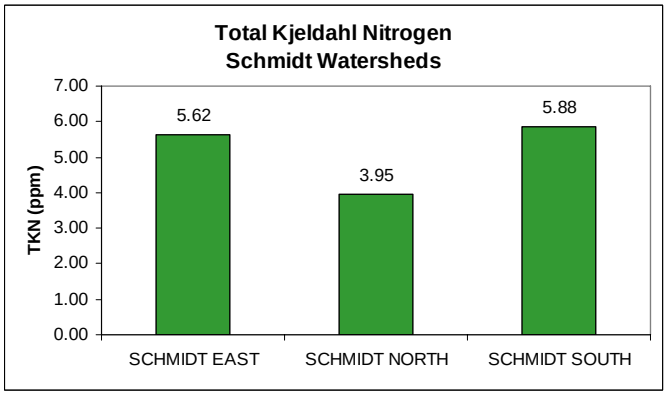
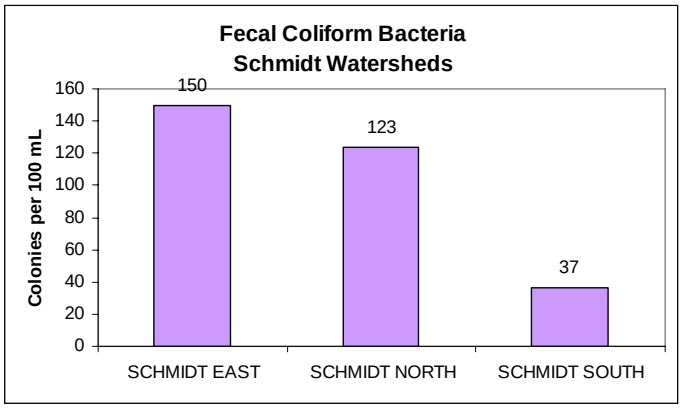


Figure 15.



On the Schmidt Watersheds no manure was applied during calibration. Cattle were allowed to graze on the crop residue during the fall and early winter of 2007.

Runoff from field plots was also collected during spring 2008 as part of the USGS 104b project titled "Evaluation of Manure Application Risk on Frozen Soils." The 1 meter x 2 meter plots were established during 2007 and were subjected to artificial rainfall during March 2008. Treatments included:

1. manure applied on frozen soil,
2. manure on frozen soil followed by snow,
3. manure applied to snow-covered soil receiving additional snow fall, and
4. a control (no manure on frozen soil).

Mean concentrations of suspended sediment (Figure 16), phosphorus (Figure 17), ammonia (Figure 18), TKN (Figure 19), and fecal coliform bacteria (Figure 20) are presented in Figures 16-20.

Figure 16.

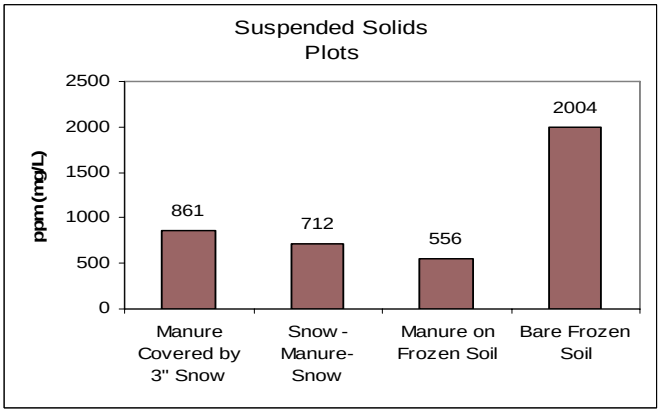


Figure 17.

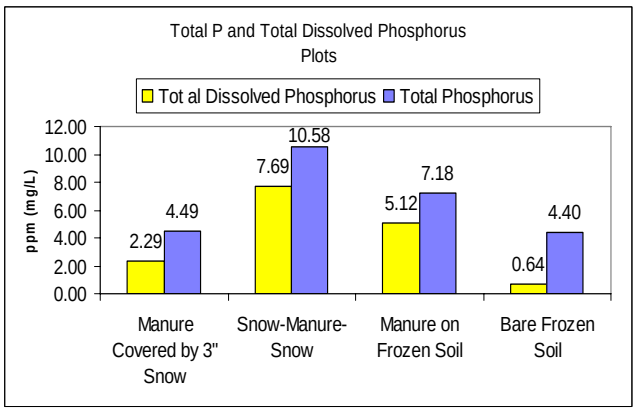


Figure 18.

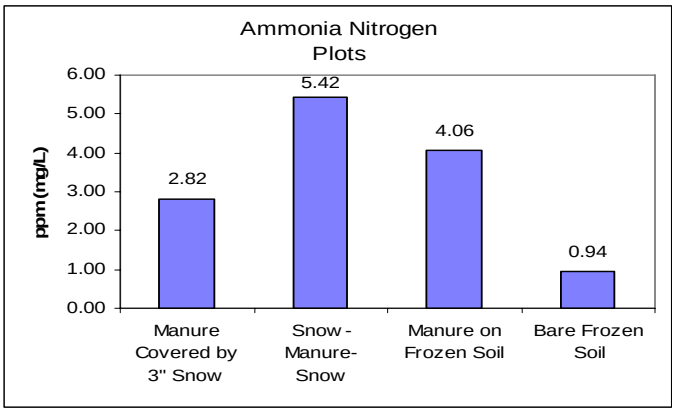


Figure 19.

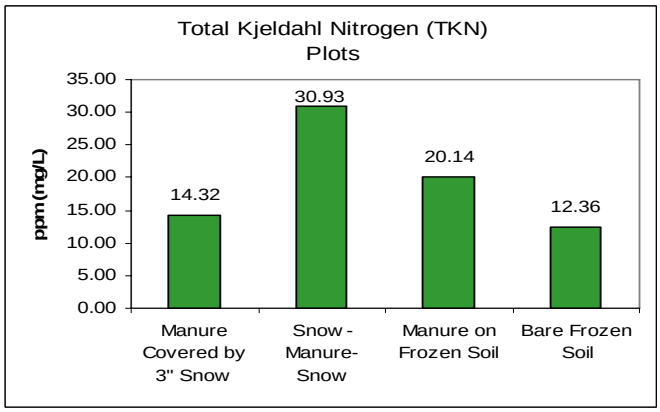
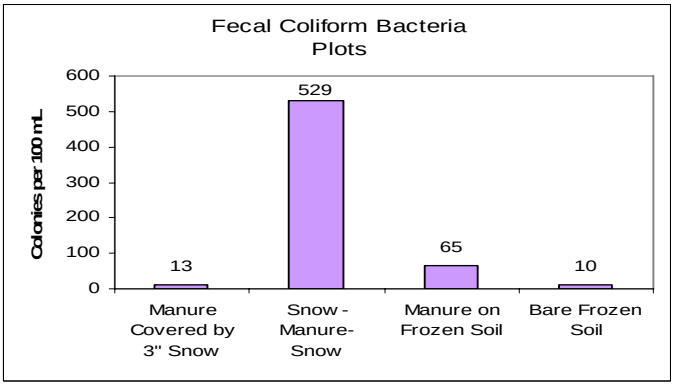


Figure 20.



The application of manure to plots reduced suspended sediment in runoff from the manured plots compared to the control (Figure 16). This is consistent with the watershed runoff results (Figure 11) and other studies (Young, 1974; Young and Mutchler, 1976; Hensler et al.,1970; McCaskey et al.,1971). Plots receiving a winter manure (surface application) exhibited higher concentrations of nutrients and fecal coliform bacteria numbers compared to the control (Figures 17-20). The snow-manure-snow plots exhibited higher concentrations of phosphorus, ammonia, TKN, and number of fecal coliform bacteria compared to the control or the other manured plots (Figures 17-20). The plot runoff data indicates that timing of winter manure applications and surface condition during placement are important factors in determining concentrations of nutrient in runoff. This information will be useful in evaluation of risk of manure applications on frozen soils at different times of the year and different surface conditions and will be used to develop BMPs.

The plot studies completed in 2008 evaluated several treatments of winter manure applications followed by spring rainfall. A more common condition is natural snowmelt without rainfall as temperatures rise in the spring. To evaluate the effect of winter manure applications on runoff during snowmelt events without rainfall, plots will be established using the same treatments and monitored for runoff during spring 2009. Three treatments plus a control with 4 repetitions on tilled and untilled corn stubble will result in runoff from 32 plots each year. An average of two snow melt events per year are anticipated. One set of plots will be established on untilled corn

stubble and a second set will be established on fall-tilled corn stubble as recommended by the project steering committee. Additional treatments will be selected by the steering committee and evaluated during 2010 and 2011. The plot studies will yield additional information on timing and placement of winter-applied manure with various surfaced conditions while the watershed scale runoff monitoring evaluates manure distribution strategies that can only be tested on a larger scale.

Detailed records of farm activities, such as location and amount of manure spreading, fertilizer used, and so on, will be kept in order to relate changes in water quality to changes in manure management practices during the evaluation phase. The paired watershed design will allow an evaluation of different practices of winter spreading of manure. The specific practices that will be evaluated each year will be recommended by the project steering committee and the principal investigators.

For each year of the proposed project, runoff from a projected 3.5 natural snowmelt and/or precipitation events will be collected by use of grab samples and automatic samplers at each of the six watersheds. Water samples will be collected from automatic samplers and flumes as soon as possible following runoff events. Samples will be collected each 30 minutes by an automatic sampler at each site during each runoff event. Samples will be selected for analysis to describe first flush, rising limb of the hydrograph, peak flow, and falling limb of the hydrograph. The automated system alerts investigators of both rainfall and runoff.

A total of 488 water samples, 145 soil samples and 7 manure samples will be collected over a three-year period. This includes 10 percent of the total samples that will be collected for QA/QC. Samples will be stored in polyethylene or polycarbonate bottles at 4°C and transported immediately to the lab for analysis. Each sample will be analyzed for nitrate nitrite-nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN), total phosphorus (TP), total dissolved phosphorus (TDP), total suspended solids (TSS), and fecal coliform/100 ml. Fecal coliform bacteria samples will be collected by grab sample using sterilized sample bottles during spring snowmelt and following rain induced runoff. Sample analysis will be by established procedures (standard methods) (AWWA, 1998) (EPA, 1983).

The soil chemical and physical properties of 6 small watersheds will be determined annually. Samples will be collected from 0-2 and 0-6 inch depth intervals to establish initial characteristics for each of the six watersheds (three existing plus three additional). A composite soil sample at each depth increment will be obtained through an intensive grid sampling scheme. This will be used to establish the average soil P and N-value of each watershed. These samples will be analyzed by SDSU Soil and Plant Testing Laboratory and will include values for pH, Olsen extractable P, nitrate-N, ammonium-N, organic matter, and soluble salts. A total of 1 composite sample at two depths and for 6 watersheds will be collected for each of three years for a total number of soil samples = 36 in three years.

Task 1: Assess runoff volumes, and nutrient and bacteria loss from the three existing watershed areas and three new watershed areas to evaluate fall versus winter manure application and winter manure spreading BMPs.

Product 1: Evaluation of runoff volumes nutrient, sediment, and fecal coliform bacterial loadings in six paired watersheds.

Cost: Analysis cost of $29,687 are as shown in the table below. Travel to watersheds = 2950 miles @ $0.32/mile = $944 in a car and 4000 miles @ $0.51/mile = $2040 in a pickup for total travel cost of $2984.

Source	Number of Watersheds	Samples per Event	Events per Year	Years	QA/QC	Number of Samples	Cost Per Sample	Total Cost
Watershed Runoff Samples	6	4	3.5	3	25	277	$102.50	$28,413
Watershed Soil Samples	6	1	2	3	4	40	$27.00	$1,069
Manure Analysis	2	1	1	3	1	7	$31.00	$205
								$29,687

Product Cost: $ 32,671 **319 Cost:** $ 7,096 **Match:** $ 25,575

Responsible Agencies:

Implementation:
- Principal Investigators 1, 2, and 3 (see Appendix 2)
- Information Specialist
- SDSU Analytical Services
- Project Steering Committee
- Natural Resources Conservation Service
- SDSU Soil Testing

Financial Assistance
- SDSU Water Resources Institute (labor only):
- Producer groups (lab only):

Milestones: Install soil sensors in six small watersheds by March 2009.

Milestones: Soil chemical and physical properties determined each year during April and October.

Milestones: Calculate total runoff volumes and loadings for six watersheds each year in December.

Milestones: Quantification of risk of winter manure spreading during December 2009 and June 2011.

Product 2: Evaluation of runoff volumes nutrient, sediment, and fecal coliform bacterial loadings in 36 plots.

Cost: Analysis cost of $27,562 are as shown in the table below. Travel to plots will be conducted in conjunction with watershed monitoring.

Source	Number of Watersheds	Samples per Event	Events per Year	Years	QA/QC	Number of Samples	Cost Per Sample	Total Cost
Plot Runoff Samples	32	1	2	3	19	211	$102.50	$21,648
Plot Soil Samples	32	1	1	3	10	106	$27.00	$2,851
								$24,499

Product Cost: $ 24,499 **319 Cost:** $ 0.00 **Match:** $ 24,499

Responsible Agencies:

Implementation:
- Principal Investigators 1, 2, and 3 (see Appendix 2)
- Information Specialist
- SDSU Analytical Services
- Project Steering Committee
- Natural Resources Conservation Service
- SDSU Soil Testing

Financial Assistance
- SDSU Water Resources Institute (labor only):
- Producer groups (lab only):

Milestones: Install soil sensors in 32 plots by March 2009.

Milestones: Soil chemical and physical properties determined each year during October.

Milestones: Calculate total runoff volumes and loadings for 32 plots each year in July.

Milestones: Quantification of risk of winter manure spreading by October each year.

Objective 2: Compare winter manure spreading practices related to location, timing and placement to determine which minimize impacts to water quality and develop BMPs.

Task 2: Develop winter manure spreading BMPs which minimize impacts to water quality.

BMPs are used to reduce environmental risks to an acceptable level. Winter spreading has been avoided in some states or allowed under varying situations because of lack of understanding of the risks involved with the practice. Producers are reluctant to change practices because of lack of scientific literature. Policy makers are reluctant to change policy for the same reasons.

The results of the watershed runoff data coupled with precipitation, temperature and frozen soil data will be used to assess the risks to water quality from the manure management practices under study. The data will be used to provide guidance to producers and policy makers on the impact of their decisions. Currently, RUSLE2 is used in many states as the tool to assess risk of land application sites for winter spreading, and is the source for that assessment in recent revisions to the South Dakota NRCS Nutrient Management 590 Standard. The watersheds in this study will be compared using estimates calculated using RUSLE2. The results from the collected data will then be compared to model estimates. In addition, the watershed study area may be assessed using the Water Erosion Prediction Project (pending further 104b funding) to allow for runoff and erosion estimates to be calculated (RUSLE2 only calculates erosion). In addition, the WEPP software has the ability to interface with a Geographic Information System, so that, if successful, could be adopted at the field- and small watershed-scale.

Product 3: Quantification of risk for four BMPs for land application of manure which includes winter spreading, P guidelines, nutrient sampling, etc.

Cost: Labor costs are included in the overall budget

Responsible Agencies:

Implementation:

- Principal Investigators 1, 2, and 3 (see Appendix 2)
- NRCS
- SDSU Cooperative Extension Service
- SDSU Soils Extension Specialist
- Project Steering Committee
- Information Specialist

Financial Assistance:

- Water Resources Institute (labor only)

Milestones: Data will be analyzed in November each year and risk calculations for BMPs will be completed during December 2010 and June 2011.

Objective 3: Develop a factor for climatic risk using frequency of soil frost and rainfall events on the risk of manure application

Little work has focused on analyzing weather data to determine the risk of occurrence of conditions that are perceived as potentially detrimental to water quality from manure application on frozen ground. All economic development, whether agricultural, municipal or industrial, is carried out with the understanding of risks and implementation of policies and rules to minimize

risks, especially with regard to human health and safety. The South Dakota State Climatologist is assessing trends and changes in temperature and precipitation over the region as well as introducing soil moisture measurements to the state. The climatologist is the PI on a project titled "Evaluation of manure application risk on frozen soils" funded through the USGS 104b program. Historical soil temperature and precipitation data will be used to establish average and ranges of the time of soil freeze-up and the risk of occurrence of rainfall events during seasons. Analysis of historical data for changes/trends in rainfall rates and freezing time of soils will occur with existing historical data sets. These data sets are necessary to determine what length of time to expect frozen soils in South Dakota and what is the risk of having rainfall to produce run-off on frozen soils. Also determining if there have been changes over time will add value to the recommendations. The USGS 104b study began during 2007; the results are shown in figures 16-20.

To supplement the runoff data, additional weather and soil data must be collected on-site. Each watershed will be monitored for soil moisture and soil temperature recorders at two levels 5 cm (2 in.) and 20 cm (8 in.). These depths are chosen to measure a near-surface value and a depth value for temperature and moisture. These instruments will be located in at least two locations per watershed, one lower in the watershed and a second higher in the watershed.

Several important pieces of information will be gathered from temperature and moisture data. 1) Is the soil frozen and 2) to what depth? What are the near-surface and deeper soil moisture conditions in the watershed? While it is not possible to monitor the complete watershed, sites will be chosen to be representative of the watershed. To determine spatial variability in soil moisture a portable soil moisture probe will be used to take a "snapshot" of the distribution of soil moisture in each watershed by taking measurements and recording their location on a grid using a GPS.

The soil moisture and temperature data will be used to establish relationships between snowmelt and rainfall rate and run-off amounts in the watershed. The amount of snow fall and precipitation will help determine the risk of runoff from the test area. Rainfall rates and total rainfall will be determined by either a standard rain gauge and/or tipping bucket rain gauges on each test site. The climatological data will used to establish a link between the watershed scale water quality, manure spreading practices, winter weather conditions and climatic factors that affect runoff.

Task 3: Collect weather and other data to assess climatic factors as they relate to runoff from six watersheds

Product 4: Rain, soil moisture and temperature data at all six watersheds during the project period.

Cost: Travel to the watershed areas will coincide with other activities. Supplies including installation of soil sensors, charts, filters, and consumables and other consumables = $12,500.00

Product Cost: $12,500.00

Responsible Agencies:

Implementation:
Principal Investigators 1, 2, and 3 (see Appendix 2)
Weather Technician or Students

Milestones: Data acquisition started by January 2009 and continues.

Objective 4: Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and various environmental stakeholders.

The extension portion of the project is based on the hypothesis that research conducted in South Dakota with the involvement of stakeholders will be more credible and will lead to a greater acceptance of results and adoption of the BMPs developed.

The Cooperative Extension Service (CES), Natural Resources Conservation Service (NRCS), and South Dakota Department of Environment and Natural Resources (SD DENR) are important components of this project. The SDSU CES has developed statewide contacts with livestock and other producers. This project will utilize these programs and contacts to conduct information transfer regarding fecal coliform contamination and nutrient loading to surface water resources. The Extension Soil Fertility Specialist will disseminate study findings to livestock producers through fertility meetings and manure management training for permitted feedlot operators in South Dakota. The South Dakota Cooperative Extension Service Environmental Quality Engineer coordinates state environmental training for operators of concentrated animal feeding operations (CAFO) (a SD DENR requirement) and is expected to work on a team working with the NRCS to address winter spreading in their revised Nutrient Management Standards (590). Livestock specialists with the CES will also incorporate the findings of this study in the educational programs they deliver to livestock producers.

The information gained from this project will also be used in a more formal educational format. SDSU CES/NRCS/SD DENR offer approximately three or four manure management seminars or short courses each year. These seminars are part of the Environmental Training Program for CAFOs that are required by SD DENR for permitting purposes. The results of the winter manure spreading studies will be used to raise awareness of livestock and crop producers of BMPs for land application of manure to reduce non-point source loading to water resources of South Dakota. Project results will also be made available to livestock producers through the education requirement as part of the new NRCS 590 standard.

The project results generated will also be used to educate undergraduate students at SDSU. SDSU faculty teaches a manure management unit as part of the swine production course (AS 478) and Agricultural Waste Management (AST 463). The project will provide needed knowledge that can be incorporated into the learner outcomes of the course. This will help students realize the importance of proper manure management and equip them with knowledge they can use back on the home farm.

Task 4: Information transfer.

Product 5: A website to display state maps showing the relative risk times for manure application, especially frozen soil times, and rainfall periods..

An information specialist at the Water Resources Institute will develop a web page to display risk maps that will be developed as part of the USGS 104b project "Evaluation of manure application risk on frozen soils". The website will display maps to show the areas of the state and relative risk times for manure application, especially frozen soil times, and rainfall periods. The website will allow livestock producers access to the output of the USGS 104b project and the proposed project. Links will be created to websites maintained by the Water Resources Institute and the State Climatologist.

Cost: Labor costs are included in the overall budget

Responsible Agencies:

Implementation:
Principal Investigators 1, and 3 (see Appendix 2) and Information Specialist

Financial Assistance:
Water Resources Institute (labor only)

Milestones: The website will be developed by December 2009 and updated each year as new information becomes available.

Product 6: Educational brochures, fact sheets, and handouts. Early in the project these media will be used to explain information about winter manure spreading gathered from the literature. As the project progresses the field results will be used to update educational tools which will be distributed to livestock producers, extension educators, and various environmental stakeholders. Information in these educational tools will explain the benefits of using BMPs during winter manure applications and to identify times of year when risk of contaminating water resources is greatest. An Extension Extra will be produced at the end of the project and will be incorporated as a supplement for individuals developing manure management plans.

Cost: Brochures: 150 copies at $1.00 per copy; Handouts: 350 copies at $0.20 per copy. Extension Extras 500 copies at $5.00 per copy.

Product Cost: $ 2,720.00

Responsible Agencies:

Implementation:
Principal Investigators 1, 2, and 3 (see Appendix 2)
SDSU Soils Extension Specialist
SDSU Cooperative Extension Service
SDSU Print Laboratory

Information Transfer:
SDSU Soils Extension Specialist
Other SDSU Cooperative Extension Service Educators
SDSU Water Resources Institute

Project Steering Committee
SD DENR

Financial Assistance:
Beef Industry Council (Extension Extras)

Milestones: Approximately 500 total copies of brochures and handouts will be produced. Also 500 copies of an Extension Extra will be published by Ag Communications after completion of the project. Materials will be distributed by manure management seminars/training sessions and other events. Updated brochures, handouts, and pamphlets will be prepared for subsequent workshops and other presentations.

Product 7: Six manure management workshops, and manure and fertilizer training sessions.

Cost: Mileage for manure management seminars, training sessions and conference presentations =$1,500.

Product Cost: $1,500.00

Responsible Agencies:

Implementation:
Principal Investigators 1, 2, and 3 (see Appendix 2)
SDSU Soils Extension Specialist
SDSU Print Lab

Information Transfer:
SDSU Soils Extension Specialist
SDSU Cooperative Extension Service
SDSU Water Resources Institute
SD DENR

Milestones: Conduct six P management workshops and eight manure/fertilizer training sessions for years 2009, 2010 and 2011.

Product 8: Prepare project mid year annual and final report describing runoff volumes, water quality, and manure management BMPs.

Cost: Each report will cost $7.50 for a total cost of $75.00. Submit 2 manuscripts for publication = $1,485.00

Product Cost: $1,560.00

Responsible Agencies:

Implementation:

Principal Investigators 1, 2, and 3 (see Appendix 2)
SDSU Print Lab

Financial Assistance (manuscript):
SDSU Water Resources Institute
Beef industry Council

Milestones: Prepare semi-annual reports during April 2009, 2010, 2011. Annual reports prepared in September 2009, 2010 & 2011. Ten copies of a final report will be prepared by June 30, 2012. Two manuscripts will be prepared and submitted for publication in a refereed, scientific journal, one in year 2 and one at the end of the project.

3.2 **Milestone Table (See following Table)**

Milestone Table: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading

Objective/Task/Products	Quantity	Groups *	Year 1												Year 2												Year 3																	
			Mar 2009 – Dec 2009												Jan 2010 – Dec 2010												Jan 2011 – Dec 2011												2012					
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Objective 1																																												
Task 1: Runoff and pollutants from 6 watershed areas																																												
Product 1: Evaluation of runoff in 6 paired watersheds	277 samples	1,4,11																																										
Install soil sensors	6 watersheds	1			6																																						
Soil properties of all 6 watersheds	36 samples	1,3				6						6						6						6						6						6								
Maintain flumes at 6 watersheds	6 watersheds	1			6																																						
Calculate total runoff volumes and loadings	6 watersheds	1												6													6												6				6	
Quantification of risk of winter manure spreading	4 BMPs	1																							2																2			
Product 2: Evaluation of runoff from 32 plots	32 plots	1,4,11																																										
Install plot boundaries		1																																										
Collect snowmelt runoff	211 samples	1																																										
Calculate runoff volumes and loadings	32 plots	1																																										
Evaluation of water quality effects	3 BMPs	1																																										
Soil properties of 32 plots	106 samples	1,3																																										

* Groups:

1. Principal Investigators 1, 2, and 3
2. Natural Resources Conservation Service
3. SDSU Soil Testing
4. SDSU Analytical Services
5. SDSU Cooperative Extension Service
6. SDSU Soils Extension Specialist
7. Project Steering Committee
8. SDSU Print laboratory
9. SD Beef Industry Council
10. SD DENR
11. Program Assistant
12. Weather Technician

Milestone Table: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading (continued)

Objective/Task/Products	Quantity	Groups *	Year 1												Year 2												Year 3																	
			Jan 2009 – Dec 2009												Jan 2010 – Dec 2010												Jan 2011 – Dec 2011												2012					
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Objective 2																																												
Task 2: Develop BMPs																																												
Product 3 Develop 4 BMPs	4 BMPs	1,2,5,6,7 11																									2																	2
Objective 3																																												
Task 3: Collect weather and soil data																																												
Product 4: Weather and soil data	6 watersheds	1,12	6																																								
Objective 4																																												
Task 4: Information Transfer																																												
Product 5: Create and update website to display risk maps	1 website	1,11												1												X												X					X
Product 6: Develop brochures, fact sheets, and handouts	500 total copies	1,2,5,6,7 ,8,10,11												125												125												125					125
Product 7: Manure management seminars and training sessions																																												
Workshops	6 workshops	1,5,6,8, 10											2												2												2						
Manure/fertilizer training	8 sessions	1,5,6,8				2												2												2												2		
Product 8: Prepare manure management mid-year and annual reports	7 reports	1,8,11				1							1					1					1						1						1								1
	2 manuscripts	1,9																							1																			1
Local Steering Committee	5 meetings	1,2,5,6,7 10	1											1										1												1							1

* Groups:

1. Principal Investigators 1, 2, and 3
2. Natural Resources Conservation Service
3. SDSU Soil Testing
4. SDSU Analytical Services
5. SDSU Cooperative Extension Service
6. SDSU Soils Extension Specialist
7. Project Steering Committee
8. SDSU Print laboratory
9. SD Beef Industry Council
10. SD DENR
11. Program Assistant
12. Weather Technician

3.4 Permits

The project sponsor will secure all necessary permits including 401, 404, and stormwater construction permits prior to implementation of any grant fund activity that may fall under applicable federal, state, or local laws. The sponsor will comply with cultural resource and threatened and endangered species clearance requirements. Cultural resource clearances will be conducted using guidance provided by DENR Practices with potential to affect listed threatened and endangered species in the area will follow procedures provided through USFWS.

4.0 COORDINATION PLAN

4.1 Project Sponsors

South Dakota State University
The proposed project will be completed by South Dakota State University, the South Dakota State Climate Office, SDSU Water Resources Institute, SDSU Soil and Plant Testing Laboratory - Plant Science Department, and the Cooperative Extension Service. South Dakota State University will be the lead institution. Sample collection and analyses will be coordinated with the Soil and Plant Testing Laboratory and Analytical Services at SDSU. Agency/project partner responsibilities for each group involved in the project are listed below. Letters of support for the project may be found in Appendix 1.

The SDSU staff members assembled for the project have a history of serving the agricultural community through research and extension. Laboratories on the SDSU campus have the capability and capacity to conduct the water and soil sample analyses. The Oscar E. Olson Biochemistry Laboratory will perform all chemical analyses on manure samples and water samples collected for nutrient analysis. The Soil and Plant Testing Laboratory will conduct all soil sample analysis.

The project team has access to the SDSU Agricultural and Biosystems Engineering shop and/or the SDSU physical plant shop for construction of the runoff gauging equipment. The project team has access to an irrigation and hydrology laboratory which is located in the Agricultural Engineering building. All equipment necessary to build the stilling wells and flumes is available.

The office of the SD state climatologist is located on the SDSU campus and has access to current as well as historic climatological data necessary to estimate weather related risks associated with manure applications. Both the Water Resources Institute and State Climatologist maintain websites to distribute information to the public. The Water Resources Institute has an Information Specialist who will coordinate with the State Climatologist to disseminate project information.

Moody Conservation District
The Moody Conservation District (MCD) will be a partner with SDSU to develop winter manure management BMPs by sponsoring a conservation commission grant of $25, 037 to provide part of the laboratory costs associated with monitoring runoff from watersheds and plots. The Moody Conservation District will also contribute a representative to the project steering committee.

East Dakota Water Development District
The East Dakota Water Development District (EDWDD) will be a partner with SDSU to develop winter manure management BMPs by contributing $9,000 over a three-year period to provide part of the laboratory costs associated with monitoring runoff from watersheds and plots. The EDWDD will also contribute a representative to the project steering committee.

Other Organizations
The Beef Feeder Council and South Dakota Farm Bureau (SDFB) have pledged support for the project and will contribute matching funds for soil and water sample analysis. The Beef Feeder Council has pledged a minimum of $1,500 for analysis costs and may contribute more at a later date.

USDA Natural Resources Conservation Service:

The Natural Resources Conservation Service (NRCS) provides leadership in partnership with other agencies and organizations to help individuals conserve, maintain, and improve our natural resources and environment. As with the ongoing P runoff project, the NRCS supports the proposed project. The NRCS will use the results of this project when providing technical assistance to livestock producers and in the development of 590 standards. They will also be consulted in the identification of demonstration areas and the soil characteristics within each area. The NRCS will also assist the cooperating landowner by providing a portable scale to weigh loads of manure applied to study water sheds.

South Dakota State University and Cooperative Extension Service:

The Cooperative Extension Service is vital to the success of the proposed project. The SDSU Soils Extension Specialist will devote part of his/her time to dissemination of the results generated by the research. Much of the information gained from the project will be used to educate area livestock producers, crop advisors, land managers, Extension Educators, undergraduate animal science students, and the general public. Results will be disseminated primarily through educational seminars/short courses, workshops, and formal instruction. The state climatologist will work on educational aspects related to climate.

South Dakota Department of Environment and Natural Resources:

The SD Department of Environment and Natural Resources (DENR) is tasked with developing requirements for nutrient management for South Dakota as mandated by the EPA. Information gained about nutrient and bacteria loss in runoff at the watershed scale will be useful in developing reasonable requirements that protect the water quality of South Dakota's streams and lakes without placing undue hardships on livestock producers.

4.2 Local support

This proposal was developed with livestock industry support. Stakeholder involvement will be important throughout this project. The project steering committee will be used to plan the research and education portion of the project. The cooperation of individual livestock producers is also vital for the success of the research phase of this project since they have offered the use of cropland watersheds for on-farm evaluation of manure management BMPs. Stakeholders will be involved in the research on water quality impacts of various manure management. Three small watersheds on their operations will be monitored for fecal coliform bacteria, sediment, phosphorus, and nitrogen. Cooperating livestock producers will also provide field history information concerning manure application and general field management.

Project Steering Committee:

To involve stakeholders in the project, a steering committee has been established. The committee consists of cooperating landowners as well as representatives from state-wide producer groups that have an interest in manure management and the issue of winter spreading.

The steering committee will help identify priorities for practices that will be studied within the six experimental watersheds.

This ad hoc group will be used as an interface between University personnel and Agency staff at the State and Federal level. This group will also be included in the information transfer activities of this project. As information is transferred to this group it will be passed on to individual producers through each organization's newsletters and meetings.

Members of this group includes SDSU staff, Moody Conservation District, East Dakota Water Development District (EDWDD), SD Department of Environment an Natural Resources, the SD Department of Agriculture, the South Dakota Cattlemen's Association (SDCA), SD Pork Producers, SD Soybean growers, South Dakota Beef Industry Council, and SD Farm Bureau will also contribute a portion of the match (lab costs and publications).

4.3 Non-Duplication of Effort

This proposed project is designed to develop improved manure management strategies and improved technical assistance to livestock producers for manure management. It is further designed to complement rather than duplicate efforts of the current USGS funded project titled "Evaluation of manure application risk on frozen soils." The project will also compliment CES programs, the Animal Waste Team, and the NRCS. This project will coordinate existing assistance to maximize efficient partnerships and to improve manure management in South Dakota. Information will be transferred to user groups and assistance providers through existing successful programs whenever possible.

5.0 EVALUATION AND MONITORING PLAN

Collection and analysis of all project data will be accomplished in accordance with the South Dakota Non-point Source Program Quality Assurance Project Plan and the project specific procedures outlined in the remainder of section 5 of this proposal.

5.1 Project Evaluation

Evaluation of success in reaching the project goal will be accomplished by monitoring project activities to measure:

1. progress toward meeting established milestones,

2. progress toward evaluating the environmental risk of spreading manure in the winter months using studies at the watershed scale, and

3. contribution to and use of the data in the development of improved manure management BMPs and their adoption by the SD DENR and the NRCS.

For objectives one and two, documentation of the project activities related to soil moisture and temperature monitoring and water quality monitoring will be used to evaluate success (i.e. number of soil samples collected and analyzed or number of runoff plots tested or runoff samples collected at discharge locations). Project monitoring will be completed by a team of staff from the SDSU State Climate Office, Plant Science Department, and Water Resources Institute.

The data collected will be stored and managed by the project staff under the direction of the Project Coordinator. Collection and analysis of data will be accomplished in accordance with the South Dakota Nonpoint Source Program Quality Assurance Project Plan. Water quality data related to runoff plots will be entered into the WRI database and made available to the DENR and any other agency requesting the data. Soil test results will be kept in the SDSU Soil Testing Lab database. Water quality data will also be submitted to SD DENR to be entered into STORET. QA/QC for all water quality monitoring and soil testing aspects of the project will be provided by the Water Quality Lab and the SDSU Soil Testing Lab.

For objective three, documentation of maps produced will be provided including a record of all climate risk maps developed during the project.

For objective four, a record of all educational materials produced and events held will be kept including requests for materials. Actual changes in producer and stakeholder behavior with regard to P management will be more difficult to document.

Semi-annual reports will include current activities and an evaluation relative to project milestones as well as cumulative progress toward reaching the project goal. The reports will contain a financial summary showing match, income and expenses. A final report will be completed at the end of this project

The ultimate indicator of success of this project will be determined by the validity of the data produced and its use as the basis for improved manure management BMPs and how well the BMPs are adopted by livestock producers. Project success will be realized if the acquired data is used to revise current manure application guidelines established by the SD DENR and NRCS under the 590 standard. Another indicator of success will be publication of these manure management BMPs in peer reviewed scientific journals.

6.0 Budget

BUDGET TABLE

Part 1. Funding Sources				
	2009	2010	2011	TOTAL
EPA Section 319 Funds				
FY Funds (FA)	$57,411	$47,071	$56,552	$161,034
State/Local Match	$18,062	$18,062	$13,950	$50,074
SDSU (FA)	$19,132	$17,735	$20,419	$57,286
Other Federal Funds	$0	$0	$0	$0
TOTAL BUDGET	**$94,605**	**$82,868**	**$90,921**	**$268,395**
FA: Financial Assistance				
TA: Technical Assistance				
SDSU: South Dakota State University				
EPA: Environmental Protection Agency				

Project Title: Developing BMPs to minimize the water quality impacts of winter manure spreading

Principal Investigators: German, Todey, Gelderman
Proposed Start Date: March 1, 2009

COST CATEGORY	Federal First Year	Non-Federal First Year	Federal 2nd Year	Non-Federal 2nd Year	Federal 3rd Year	Non-Federal 3rd Year	Total Project Costs
1. Salaries and Wages							
*PI Gelderman	$0	$2,125	$0	$2,232	$0	$2,343	$6,700
*PI Todey	$1,455	$0	$1,528	$0	$1,604	$0	$4,588
Technician-Shukla	$0	$0	$0	$0	$0	$0	$0
*PI German	$20,897	$5,224	$21,941	$5,485	$23,038	$5,760	$82,346
Information Specialist	$2,895	$1,737	$3,040	$0	$3,192	$0	$10,865
Undergrad Student Labor	$2,000	$0	$2,100	$0	$2,000	$0	$6,100
Total salaries & wages	$27,247	$9,087	$28,610	$7,717	$29,835	$8,103	$110,598
2. Fringe benefits	$6,598	$2,370	$6,928	$1,852	$7,270	$1,944	$26,963
3. Equipment	$0	$0	$0	$0	$0	$0	$0
4. Supplies	$10,500	$0	$1,000	$0	$1,000	$0	$12,500
5. Services or consultants (lab)	$0	$18,062	$0	$18,062	$4,112	$13,950	$54,186
6. Travel	$1,149	$0	$750	$0	$2,585	$0	$4,484
7. Publication Costs	$70	$0	$70	$780	$80	$3,280	$4,280
8. Other direct cost	$0	$0	$0	$0	$0	$0	$0
9. Total Direct Costs (sum 1-8)	$45,564	$29,519	$37,358	$28,411	$44,883	$27,277	$213,012
10. Indirect cost (26%)	$11,847	$7,675	$9,713	$7,387	$11,669	$7,092	$55,383
11. Amount Proposed (9+10)	$57,411	$37,194	$47,071	$35,797	$56,552	$34,369	$268,395
TOTAL FEDERAL							$161,034
TOTAL LOCAL							$107,360

Appendix 1

Letters of Support

For

Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading

East Dakota Water Development District
132B Airport Drive
Brookings, SD 57006

605-688-6741 **605-688-6744 Fax**

MEMORANDUM

TO: Pete Jahrus, SD DENR 319 Coordinator

FROM: Jay Gilbertson, Manager

DATE: September 30, 2008

TOPIC: EDWDD Support for "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading" Project

On September 18, 2008, the Board of Directors of the East Dakota Water Developmrent District (District) agreed to provide cost-share assistance to the Water Resources Institute (WRI) at the South Dakota State University for their proposed project entitled **Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading**. Specifically, the District has agreed to provide $3,000 per year for each of the three years of the project, a total of $9,000.

The Board has previously supported preliminary efforts by the WRI to assess the impacts of winter application of manure. While the Board understands that wintertime application of manure is a practice that is, and should be, largely discouraged due to water quality concerns, it also understands that this is a common practice none the less. In the absence of strict and explicit prohibitions, this practice is likely to continue, particularly for smaller animal feeding operations.

The Board believes that the current WRI proposal will help identify those manure management practices that would minimize the possible adverse impacts of wintertime spreading. There are clearly some factors (timing and rates of application, presence and/or depth of snow pack, temperature) that will affect the amount of nutrient and bacteria laden runoff, and avoiding these conditions may significantly reduce the impact on area water bodies. Until such time as this problematic practice can be avoided all together, the Board believes that this proposal can help develop viable best management practices to minimize environmental risks.

FROZEN GROUND MANURE MANAGEMENT RESEARCH

A livestock producer that utilizes the Natural Resources Conservation Services (NRCS) Environmental Quality Incentives Program (EQIP) to cost share waste containment facilities is required to comply with Conservation Practice Standard 590 (590). 590 does not allow a livestock producer to land apply manure to frozen and/or snow covered ground except in emergency situations. In South Dakota a producer can encounter snow as early as late October, the frost may not go out of the ground until April, and when it does the fields are likely much too soft to land apply manure without creating rutting and compaction problems. During the growing season a significant portion of the cropland is planted to full season crops that may not be harvested until the ground is again frozen. The restrictions of 590 are excessive for the northern plains states of the United States and create complex logistical manure handling problems that are complicated by unpredictable weather patterns. NRCS does allow states to propose modifications of the conservation practice standards but such proposed modifications usually need to be validated by sound scientific research before they are approved at the national level. This proposed research project would attempt to identify the types of field situations, crop residue, tillage (if need be), terraces, slope, etc. that would have a runoff risk at a reduced level that would be acceptable to permit the land application of manure to frozen and/or snow covered ground.

Building manure storage structures is also expensive. Land applying manure the first time that it is handled makes economic sense. Rather than spending producer and/or cost share dollars to build such manure storage facilities and handling some of the manure multiple times the money may be better spent installing land improvement practices such as terraces and buffer strips that would reduce the risk levels to acceptable levels the year around. Such practices may offer returns beyond just reducing risk levels for manure application and help reduce erosion and improve water quality.

A research project such as this proposal will help define acceptable risk levels for the winter application of manure and also allow limited cost share dollars to be applied to multiple tasks and utilized more effectively.

Michael L. Schmidt
47640 242nd Street
Dell Rapids, So. Dak. 57022

David R German
Water Resources Institute
South Dakota State University
Brookings SD 57006

Dear Dave,

I am a rural landowner in the Central Big Sioux Water Quality Project, chairman of the Moody County Conservation District Board of Supervisors and president of the South Dakota Association of Conservation Districts. I am very interested in the proposed research project to study the effects of applying manure on frozen ground.

I was raised on a small dairy and poultry farm and know the difficulties and water quality hazards of stockpiling manure in open areas during the winter months. The Moody County Conservation District is an active participant in the Central Big Sioux Water Quality Project and we want to allow reasonable but responsible stewardship of our natural resources in Moody County. At our 2006 annual conference, the membership of SDACD passed a resolution to 'work with appropriate agencies to review the technical standards prohibiting the spreading of manure on frozen or snow-covered ground to determine if spreading could be allowed on land with little or no risk of run-off or contamination'. For these reasons, I feel I have a lot to offer to this project.

I am willing to participate in this research project and to offer my farm as a site to conduct some of the research needed to determine the effectiveness and safety of applying manure on frozen ground. I own the SW1/4 of Sec 30-105-49 which has gently rolling Moody and Moody Nora silty clay loam soils. The majority of the farm is terraced and farmed on the contour using minimum tillage practices. The portion I would recommend for the study, approximately 100 acres, does not receive any runoff water from adjoining property. It will be in corn (60 ac), alfalfa (20 ac), and CRP (20 ac), the 2007 growing season. Runoff waters from these acres can be collected in the SW corner of our property before they enter the culvert in the township road. My renter lives one mile from our farm and has cattle and hogs. He is willing to participate in the project and apply the recommended manures as needed.

Jack Majeres
47228 243rd Street
Dell Rapids, SD
(605) 428-3090

SOUTH DAKOTA FARM BUREAU

Research for Managing Manure on Frozen Ground

South Dakota Farm Bureau (SDFB) is a voluntary farm and ranch organization with 9500 member families. Farm Bureau is a grass roots organization where the members develop and pass the policies that guide the organization.

Many of our member families raise livestock. SDFB policy states: "SDFB will become involved in or take the lead in developing a research project at SDSU to develop sound practices and acceptable limits allowing the application of manure to frozen and/or snow covered ground."

When considering weather pattern changes in our state, the window for manure application, especially if one is involved in a 590 (conservation practice) standard, is extremely limited. Feeding operations are forced to choose between trying to apply the manure when the soil is too wet which destroys the soil structure, and putting in a manure storage facility for dry manure or litter (non-liquid). This creates extra costs in facilities, machinery costs and labor because they are force to handle the material more than once.

Our members need to find an acceptable meeting place between additional conservation practices on the land, and acceptable risk from applying manure to ground that is frozen or thawed ground. We recognize the need to protect the environment. We also recognize that applying manure to thawed ground does not represent zero risk to the environment.

We do recognize the need for research in South Dakota to find the acceptable risk and the management practices necessary to broaden the window for manure application.

SDFB supports this research project!

Wayne Smith, SDFB
PO Box 1426
Huron, SD 57350

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
200 Fourth Street SW
Huron, South Dakota 57350

Phone: (605) 352-1200
Fax: (605) 352-1270

Dr. Dave German
Water Resources Institute
Box 2120
Brookings, South Dakota 57007

Dear Dr. German:

The Natural Resources Conservation Service has worked and will continue to work productively with our South Dakota (SD) partnership to integrate conservation management systems into SD producer's conservation plans which in turn protect our nation's soil and water resources.

We would like to continue this relationship so that we can further assist SD land users to apply conservation measures that will maintain the sustainability of the cropland resource, as well as, reduce or eliminate offsite environmental impacts to other resources, such as SD's surface and ground water resources.

For this reason, we are very interested in supporting the Water Resource Institute proposal on watershed scale research to assess the risk of winter spreading manure. This information would be very beneficial for future revisions of our SD Technical Guide, specifically, our Nutrient Management (590) standard.

Please feel free to contact Jeff Hemenway, Conservation Agronomist, at (605) 352-1239, if you need further assistance.

Sincerely,

JANET L. OERTLY
State Conservationist

Appendix 2

Key Personnel

for

Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading

Mr. David German (PI/PD #1) is a Limnologist and a Research Associate III at the SDSU Water Resources Institute. Mr. German has been conducting water quality research and monitoring the water quality of South Dakota lakes and streams for 25 years. He will be responsible for helping identify watershed areas, and flume sites within the watershed areas. Mr. German will spend much of his time installing soil monitoring sensors, setting up the autosamplers, installing flumes at discharge locations, and collecting water runoff from the watershed areas. Mr. German will assist with events, writing manuscripts for publication, and writing progress and final reports.

Dr. Ronald Gelderman (PI/PD #2) is the Director of the Soil and Plant Testing Laboratory at South Dakota State University. His dedication and commitment to quality assurance ensures continued laboratory certification with the North American Proficiency Testing Program of the Soil Science Society of America. Dr. Gelderman has been working in soil testing and conducting field calibration studies for 28 years. His experience and knowledge in STP determination and indices development are noteworthy and his contributions to the project are vital. Dr. Gelderman will be responsible for helping soil sample sites within the watershed areas. He will be responsible for determining initial chemical composition of soils collected from watershed areas and will oversee all chemical analyses at the SDSU Soil and Plant Testing Laboratory. Dr. Gelderman will assist with events, writing manuscripts for publication, and writing progress and final reports.

Dr. Dennis Todey (PI/PD #3) is the South Dakota State Climatologist and assessing trends and changes in temperature and precipitation over the region as well as measuring soil moisture values. He is also the SD Water Quality coordinator through a Cooperative State Research, Education, and Extension Service (CSREES) regional water quality grant. Dr. Todey will be taking a larger role in South Dakota's water quality and will work to coordinate the CSREES grant activities with those of this project wherever possible. Other work in precipitation rate changes over time will also contribute to the study. Dr. Todey will assist with events, writing manuscripts for publication, and writing progress and final reports.

When the SDSU Soils Extension Specialist position is filled during 2008, the individual will be important to the successful completion of the project. The SDSU Soils Extension Specialist attends and conducts professional meetings, in state multi-county meetings and workshops, training sessions, short courses, and field tours. Much of the information gained from the proposed project will be disseminated to area livestock producers, crop advisors, land managers, Extension Educators, undergraduate animal science students, and the general public via the Cooperative Extension Service and the SDSU Soils Extension Specialist. The dissemination of information will be through educational seminars/short courses, field day events, and formal instruction.